

## CLAIMS

What is claimed is:

1           1.     An apparatus coupled to a first network interface, comprising:  
2           a first network interface coupled to a network device on a first network in  
3     accordance with a first protocol;  
4           a second network interface to be coupled to a network processor on a second  
5     network having a second protocol; and,  
6           a processor coupled to the first network interface and the second network  
7     interface, said processor to translate said first protocol to said second protocol,  
8           wherein said apparatus receives network transfers on behalf of the network  
9     processor while operating in a first mode, and initiates network transfers on behalf  
10    of the network processor while operating in a second mode.

1           2.     The apparatus of claim 1, wherein the apparatus is a protocol bridge,  
2     the first protocol is Fibre Channel and said network device is a Fibre Channel  
3     device.

1           3.     The apparatus of claim 2, wherein the second protocol is Small  
2     Computer System Interface (SCSI) and the second network is a packet-over-SONET  
3     (POS) network.

1           4.     The apparatus of claim 1, wherein said network processor is a storage  
2 processor and the second network is a POS network.

1           5.     The apparatus of claim 1, wherein said first mode is a target mode,  
2 said apparatus to perform at least one of a target mode read operation and a target  
3 mode write operation while in said target mode.

1           6.     The apparatus of claim 5, wherein said apparatus performs the target  
2 mode read operation by,  
3                 providing a command frame to the network processor over the second  
4 network interface in accordance with the second protocol,  
5                 receiving a data frame from the network processor that is sent in  
6 response to said command frame, and  
7                 transmitting, over the first network interface, a payload of the data  
8 frame to the network device in accordance with the first protocol.

1           7.     The apparatus of claim 6, wherein said apparatus performs said target  
2 mode operation by further,  
3                 receiving a status frame from the network processor that includes a  
4 response command,  
5                 transmitting said response command to the network device in  
6 accordance with the first protocol, and

7           transmitting an acknowledgement frame to the network processor in  
8           accordance with the second protocol indicating that the target read operation  
9           is complete.

1           8.     The apparatus of claim 5, wherein said apparatus performs the target  
2           mode write operation by,  
3                     providing a command frame to the network processor over the second  
4           network interface in accordance with the second protocol,  
5                     receiving a ready frame from the network processor that is sent in  
6           response to said command frame, said ready frame to contain a transfer  
7           command and to indicate that said network processor is ready to receive  
8           data, and  
9                     transmitting, over the first network interface, the transfer command to  
10          the network device in accordance with the first protocol.

1           9.     The apparatus of claim 8, wherein said apparatus performs the target  
2           mode write operation by further,  
3                     receiving, from the network device in accordance with the first  
4           protocol, a data frame sent in response to said transfer command,  
5                     terminating the first protocol of the data frame, and  
6                     transmitting the data frame to the network processor in accordance  
7           with the second protocol.

1           10.    The apparatus of claim 9, wherein said apparatus performs the target  
2 mode write operation by further  
3                receiving a status frame from the network processor that includes a  
4                response command,  
5                transmitting said response command to the network device in  
6                accordance with the first protocol, and  
7                transmitting an acknowledgement frame to the network processor in  
8                accordance with the second protocol indicating that the target write operation  
9                is complete.

1           11.    The apparatus of claim 1, wherein said second mode is an initiator  
2 mode, said apparatus to perform at least one of an initiator mode read operation and  
3 an initiator mode write operation while in said initiator mode.

1           12.    The apparatus of claim 11, wherein said apparatus performs the  
2 initiator mode read operation by,  
3                receiving a command frame from the network processor over the  
4                second network interface in accordance with the second protocol, said  
5                command frame to contain a data request command,  
6                transmitting the data request command to the network device in  
7                accordance with the first protocol,  
8                receiving, from the network device over the first network interface, a  
9                data frame in accordance with the first protocol, and  
10               terminating said first protocol for said data frame.

1           13.    The apparatus of claim 12, wherein said apparatus performs said  
2 initiator mode read operation by further,  
3                   transmitting said data frame to the network processor in accordance  
4 with the second protocol,  
5                   receiving a response command from the network device in accordance  
6 with the first protocol, and  
7                   transmitting a status frame containing the response command to the  
8 network processor in accordance with the second protocol.

1           14.    The apparatus of claim 11, wherein said apparatus performs the  
2 initiator mode write operation by,  
3                   receiving a command frame containing a transfer command from the  
4 network processor over the second network interface in accordance with the  
5 second protocol,  
6                   transmitting the transfer command to the network device in  
7 accordance with the first protocol,  
8                   receiving a transfer ready command from the network device that is  
9 sent in response to said command, said transfer ready command to indicate  
10 that said network device is ready to receive data, and  
11                   transmitting, over the second network interface, a ready frame to the  
12 network processor in accordance with the second protocol, said ready frame  
13 to contain the transfer ready command.

1           15.    The apparatus of claim 14, wherein said apparatus performs the target  
2 mode write operation by further,  
3                receiving, from the network processor in accordance with the second  
4                protocol, a data frame sent in response to said transfer ready command,  
5                transmitting the data frame to the network device in accordance with  
6 the first protocol,  
7                receiving a response command from the network device according to the first  
8 protocol, and  
9                providing a status frame to the network processor containing the response  
10 command, said status frame to indicate that the initiator write operation is complete.

1           16.    The apparatus of claim 1, wherein said apparatus determines which of  
2 said target mode operation and initiator mode operation to perform based on one or  
3 more frame header fields.

1           17.    The apparatus of claim 16, wherein said one or more frame header  
2 fields includes a protocol field that is used to determine a frame type for frames  
3 received by said apparatus.

1           18.    The apparatus of claim 17, wherein said frame type is one of a target  
2 mode frame, initiator mode frame, raw frame, control mode frame and event  
3 reporting frame.

1           19.    The apparatus of claim 18, upon receiving a raw frame, enters a raw  
2 frame mode in which frames received over said first network interface according to  
3 said first protocol are encapsulated into a second protocol frame and sent to said  
4 network processor over the second network interface.

1           20.    The apparatus of claim 18, upon receiving a control mode frame,  
2 routes the control mode frame to a predetermined hardware queue that is different  
3 than a memory queue used for data frames, wherein said control mode frame to  
4 cause the apparatus to perform a control operation.

1           21.    The apparatus of claim 18, to communicate an asynchronous event to  
2 said network processor, provides an event reporting frame to said network  
3 processor over the second network interface.

1           22.    A protocol bridge for bridging a first protocol to a second protocol,  
2 comprising:  
3           a first network interface coupled to a network device on a first network  
4 having the first protocol;  
5           a second network interface coupled to a network processor over a second  
6 network having the second protocol; and,  
7           wherein said protocol bridge receives network transfers on behalf of the  
8 network processor when a field in a received frame indicates that the protocol  
9 bridge should operate in a first mode, and initiates network transfers on behalf of

10 the network processor when the field in the received frame indicates that the  
11 protocol bridge should operate in a second mode.

1 23. The protocol bridge of claim 22, the first protocol is Fibre Channel and  
2 said network device is a Fibre Channel device, and wherein said second protocol is  
3 Small Computer System Interface (SCSI) and the second network is a packet-over-  
4 SONET (POS) network.

1 24. The protocol bridge of claim 22, wherein said network processor is a  
2 storage processor and the second network is a POS network.

1 25. The protocol bridge of claim 22, wherein said protocol bridge operates  
2 in the first mode based on information from a received frame header field, and  
3 wherein when said received frame header field further indicates that the first mode  
4 is a target mode and that the protocol bridge is to perform a target mode read  
5 operation, said protocol bridge to,  
6 provide a command frame to the network processor over the second  
7 network interface in accordance with the second protocol,  
8 receive a data frame from the network processor that is sent in  
9 response to said command frame, and  
10 transmit, over the first network interface, a payload of the data frame  
11 to the network device in accordance with the first protocol.



1           26.    The protocol bridge of claim 25, wherein said protocol bridge, in  
2 performing said target mode read operation, is further to,  
3                    receive a status frame from the network processor that includes a  
4                    response command,  
5                    transmit said response command to the network device in accordance  
6                    with the first protocol, and  
7                    transmit an acknowledgement frame to the network processor in  
8                    accordance with the second protocol indicating that the target read operation  
9                    is complete.

1           27.    The protocol bridge of claim 22, wherein said protocol bridge operates  
2 in the first mode based on information from a received frame header field, and  
3 wherein when said received frame header field further indicates that the first mode  
4 is a target mode and that the protocol bridge is to perform a target mode write  
5 operation, said protocol bridge to,  
6                    provide a command frame to the network processor over the second  
7                    network interface in accordance with the second protocol,  
8                    receive a ready frame from the network processor that is sent in  
9                    response to said command frame, said ready frame to contain a transfer  
10                   command and to indicate that said network processor is ready to receive  
11                   data, and  
12                   transmit, over the first network interface, the transfer command to the  
13                   network device in accordance with the first protocol.

1           28.    The protocol bridge of claim 27, wherein said protocol bridge, in  
2 performing said target mode write operation, is further to,  
3                receive, from the network device in accordance with the first protocol,  
4                a data frame sent in response to said transfer command,  
5                terminate the first protocol of the data frame,  
6                transmit the data frame to the network processor in accordance with  
7                the second protocol  
8                receive a status frame from the network processor that includes a  
9                response command,  
10               transmit said response command to the network device in accordance  
11               with the first protocol, and  
12               transmit an acknowledgement frame to the network processor in  
13               accordance with the second protocol indicating that the target write operation  
14               is complete.

1           29.    The protocol bridge of claim 22, wherein said protocol bridge operates  
2 in the second mode based on information from a received frame header field, and  
3 wherein when said received frame header field further indicates that the second  
4 mode is an initiator mode and that the protocol bridge is to perform an initiator  
5 mode read operation, said protocol bridge to,  
6                receive a command frame from the network processor over the second  
7                network interface in accordance with the second protocol, said command  
8                frame to contain a data request command,  
9                transmit the data request command to the network device in  
10               accordance with the first protocol,

11                   receive, from the network device over the first network interface, a  
12                   data frame in accordance with the first protocol, and  
13                   terminate said first protocol for said data frame.

1           30.    The apparatus of claim 29, wherein said protocol bridge, in performing  
2           said initiator mode read operation, is further to,  
3                   transmit said data frame to the network processor in accordance with  
4                   the second protocol,  
5                   receive a response command from the network device in accordance  
6                   with the first protocol, and  
7                   transmit a status frame containing the response command to the  
8                   network processor in accordance with the second protocol.

1           31.    The protocol bridge of claim 22, wherein said protocol bridge operates  
2           in the second mode based on information from a received frame header field, and  
3           wherein when said received frame header field further indicates that the second  
4           mode is an initiator mode and that the protocol bridge is to perform an initiator  
5           mode write operation, said protocol bridge to,  
6                   receive a command frame containing a transfer command from the  
7                   network processor over the second network interface in accordance with the  
8                   second protocol,  
9                   transmit the transfer command to the network device in accordance  
10           with the first protocol,

11                   receive a transfer ready command from the network device that is sent  
12                   in response to said command, said transfer ready command to indicate that  
13                   said network device is ready to receive data, and  
14                   transmit, over the second network interface, a ready frame to the  
15                   network processor in accordance with the second protocol, said ready frame  
16                   to contain the transfer ready command.

1           32.    The protocol bridge of claim 31, wherein said protocol bridge, in  
2   performing said initiator mode write operation, is further to,  
3                   receive, from the network processor in accordance with the second  
4                   protocol, a data frame sent in response to said transfer ready command,  
5                   transmit the data frame to the network device in accordance with the  
6   first protocol,  
7                   receive a response command from the network device according to the first  
8   protocol, and  
9                   provide a status frame to the network processor containing the response  
10   command, said status frame to indicate that the initiator write operation is complete.

1           33.    The protocol bridge of claim 22, wherein said field in the received  
2   frame may further indicate that the protocol bridge should enter one of a raw frame  
3   mode, a control mode and an event reporting mode.

1           34.    The protocol bridge of claim 33, when in said raw frame mode,  
2   encapsulates raw frames received over said first network interface according to said

3 first protocol into a second protocol frame having the second protocol and sends  
4 said second protocol frame to said network processor over the second network  
5 interface.

1 35. The protocol bridge of claim 33, when in said control mode, routes  
2 control mode frames to a predetermined hardware queue that is different than a  
3 memory queue used for data frames, said control mode frames to cause the protocol  
4 bridge to perform a control operation.

1 36. The apparatus of claim 33, when in event reporting mode,  
2 communicates asynchronous events to said network processor by sending an event  
3 reporting frame to said network processor over the second network interface.

1 37. A method for bridging protocols, comprising:  
2 determining, based on a field of a received frame, that a target read mode  
3 operation should be performed;  
4 providing a command frame to a network processor over in accordance with  
5 a first protocol;  
6 receiving a data frame from the network processor that is sent in response to  
7 said command frame, and  
8 transmitting, over a second network interface, a payload of the data frame to  
9 a network device in accordance with a first protocol.

1        38.    The method of claim 37, further comprising:  
2        receiving a status frame from the network processor that includes a response  
3        command,  
4        transmitting said response command to the network device in accordance  
5        with the second protocol, and  
6        transmitting an acknowledgement frame to the network processor in  
7        accordance with the first protocol indicating that the target read operation is  
8        complete.

1        39.    The method of claim 38, , wherein the first protocol is Small Computer  
2        System Interface (SCSI) and the second protocol is Fibre Channel, and wherein said  
3        network processor is a storage processor and said network device is a Fibre Channel  
4        device.

1        40.    A method for bridging protocols, comprising:  
2        determining, based on a field of a received frame, that a target write mode  
3        operation should be performed;  
4        receiving, from the network device in accordance with the first protocol, a  
5        data frame sent in response to said transfer command;  
6        terminating the first protocol of the data frame; and  
7        transmitting the data frame to the network processor in accordance with the  
8        second protocol.

1           41.    The method of claim 40, further comprising:  
2           receiving a status frame from the network processor that includes a response  
3   command,  
4           transmitting said response command to the network device in accordance  
5   with the first protocol, and  
6           transmitting an acknowledgement frame to the network processor in  
7   accordance with the second protocol indicating that the target write operation is  
8   complete.

1           42.    The method of claim 41, wherein the first protocol is Fibre Channel  
2   and the second protocol is Small Computer System Interface (SCSI), and wherein  
3   said network processor is a storage processor and said network device is a Fibre  
4   Channel device.

1           43.    A method for bridging protocols, comprising:  
2           determining whether an initiator read mode operation should be performed,  
3   and if so,  
4           receiving a command frame from a network processor in accordance with a  
5   first protocol, said command frame to contain a data request command,  
6           transmitting the data request command to a network device in accordance  
7   with a second protocol,  
8           receiving, from the network device, a data frame in accordance with the  
9   second protocol, and  
10          terminating said second protocol for said data frame.

1           44.    The method of claim 43, further comprising,  
2           transmitting said data frame to the network processor in accordance with the  
3 first protocol,  
4           receiving a response command from the network device in accordance with  
5 the second protocol, and  
6           transmitting a status frame containing the response command to the network  
7 processor in accordance with the first protocol.

1           45.    The method of claim 44, wherein the first protocol is Small Computer  
2 System Interface (SCSI) and the second protocol is Fibre Channel, and wherein said  
3 network processor is a storage processor and said network device is a Fibre Channel  
4 device.

1           46.    A method for bridging protocols, comprising:  
2           receiving a command frame containing a transfer command from a network  
3 processor in accordance with a first protocol,  
4           transmitting the transfer command to a network device in accordance with a  
5 second protocol,  
6           receiving a transfer ready command from the network device that is sent in  
7 response to said command, said transfer ready command to indicate that said  
8 network device is ready to receive data, and  
9           transmitting a ready frame to the network processor in accordance with the  
10 first protocol, said ready frame to contain the transfer ready command.



1           47.    The method of claim 46, further comprising:  
2           receiving, from the network processor in accordance with the first protocol, a  
3           data frame sent in response to said transfer ready command,  
4           transmitting the data frame to the network device in accordance with the  
5           second protocol,  
6           receiving a response command from the network device according to the  
7           second protocol, and  
8           providing a status frame to the network processor containing the response  
9           command, said status frame to indicate that the initiator write operation is complete.

1           48.    An apparatus, comprising:  
2           a first network interface to be coupled to a network device on a first network  
3           in accordance with a first protocol that is terminated by said apparatus;  
4           a second network interface to be coupled to a network processor on a second  
5           network having a second protocol; and,  
6           a processor coupled to the first network interface and the second network  
7           interface,  
8           wherein said apparatus functions as a target for the network processor while  
9           performing a target mode operation, and functions as an initiator on behalf of the  
10          network processor while performing an initiator mode operation.

1           49.    The apparatus of claim 48, wherein said target mode operation is one  
2           of a target mode read operation and a target mode write operation.

1           50.    The apparatus of claim 49, wherein said apparatus performs the target  
2 mode read operation by,  
3                providing a command frame to the network processor over the second  
4 network interface in accordance with the second protocol,  
5                receiving a data frame from the network processor that is sent in  
6 response to said command frame, and  
7                transmitting, over the first network interface, a payload of the data  
8 frame to the network device in accordance with the first protocol.

1           51.    The apparatus of claim 50, wherein said apparatus performs said  
2 target mode operation by further,  
3                receiving a status frame from the network processor that includes a  
4 response command,  
5                transmitting said response command to the network device in  
6 accordance with the first protocol, and  
7                transmitting an acknowledgement frame to the network processor in  
8 accordance with the second protocol indicating that the target read operation  
9 is complete.

1           52.    The apparatus of claim 49, wherein said apparatus performs the target  
2 mode write operation by,  
3                providing a command frame to the network processor over the second  
4 network interface in accordance with the second protocol,

5           receiving a ready frame from the network processor that is sent in  
6           response to said command frame, said ready frame to contain a transfer  
7           command and to indicate that said network processor is ready to receive  
8           data, and  
9           transmitting, over the first network interface, the transfer command to  
10          the network device in accordance with the first protocol.

1           53.    The apparatus of claim 52, wherein said apparatus performs the target  
2           mode write operation by further,  
3                    receiving, from the network device in accordance with the first  
4           protocol, a data frame sent in response to said transfer command,  
5                    terminating the first protocol of the data frame, and  
6                    transmitting the data frame to the network processor in accordance  
7           with the second protocol.

1           54.    The apparatus of claim 53, wherein said apparatus performs the target  
2           mode write operation by further  
3                    receiving a status frame from the network processor that includes a  
4           response command,  
5                    transmitting said response command to the network device in  
6           accordance with the first protocol, and  
7                    transmitting an acknowledgement frame to the network processor in  
8           accordance with the second protocol indicating that the target write operation  
9           is complete.

1           55.    The apparatus of claim 48, wherein said initiator mode operation is  
2   one of an initiator mode read operation and an initiator mode write operation.

1           56.    The apparatus of claim 55, wherein said apparatus performs the  
2   initiator mode read operation by,  
3           receiving a command frame from the network processor over the  
4           second network interface in accordance with the second protocol, said  
5           command frame to contain a data request command,  
6           transmitting the data request command to the network device in  
7           accordance with the first protocol,  
8           receiving, from the network device over the first network interface, a  
9           data frame in accordance with the first protocol, and  
10          terminating said first protocol for said data frame.

1           57.    The apparatus of claim 56, wherein said apparatus performs said  
2   initiator mode read operation by further,  
3           transmitting said data frame to the network processor in accordance  
4           with the second protocol,  
5           receiving a response command from the network device in accordance  
6           with the first protocol, and  
7           transmitting a status frame containing the response command to the  
8           network processor in accordance with the second protocol.

1           58.    The apparatus of claim 55, wherein said apparatus performs the  
2 initiator mode write operation by,  
3                receiving a command frame containing a transfer command from the  
4 network processor over the second network interface in accordance with the  
5 second protocol,  
6                transmitting the transfer command to the network device in  
7 accordance with the first protocol,  
8                receiving a transfer ready command from the network device that is  
9 sent in response to said command, said transfer ready command to indicate  
10 that said network device is ready to receive data, and  
11               transmitting, over the second network interface, a ready frame to the  
12 network processor in accordance with the second protocol, said ready frame  
13 to contain the transfer ready command.

1           59.    The apparatus of claim 58, wherein said apparatus performs the target  
2 mode write operation by further,  
3                receiving, from the network processor in accordance with the second  
4 protocol, a data frame sent in response to said transfer ready command,  
5                transmitting the data frame to the network device in accordance with  
6 the first protocol,  
7                receiving a response command from the network device according to the first  
8 protocol, and  
9                providing a status frame to the network processor containing the response  
10 command, said status frame to indicate that the initiator write operation is complete.